

Assessment of Abandoned Mines for Bat Use on Bureau of Land Management Lands in the Phillipsburg, Montana Area, 1999

A Report to:

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ABSTRACT

In July 1999, three groups of abandoned mine workings on BLM lands in the Philipsburg, Granite County, Montana area were inspected for their potential use by bats. Site groups included the Russian Gulch Mine (2 adits), Frost Creek group adjacent to Philipsburg (5 adits), and the Cliff Creek group, also adjacent to Philipsburg (7 adits, 1 shaft). Where possible, workings were inspected internally for bats and bat spoor; at sites suitable and with greatest potential, mist nets were set across portals and monitored for two hours after sunset. All but the Russian Gulch Mine were shallow workings or inaccessible, and all workings exhibited low activity or low potential for significant use by bats. The Russian Gulch Mine could be made more accessible to bats, and has the greatest potential for significant use, but another nearby working (Silver King Mine) showed current bat activity (as of 1997) and is preferable for bat-friendly reclamation if limited funds preclude management for bats at both mines.

Five bat species that use caves and mines as primary hibernation habitat have been recorded from Granite County, and have the potential to occur in abandoned mine workings in the Philipsburg area. These species include the Western Small-footed Myotis (*Myotis ciliolabrum*), Western Long-eared Myotis (*M. evotis*), Little Brown Myotis (*M. lucifugus*), Long-legged Myotis (*M. volans*), and Townsend's Big-eared Bat (*Corynorhinus townsendii*). All but the Little Brown Myotis are U.S. Fish and Wildlife Service Special Concern species, and Townsend's Big-eared Bat is also a BLM Special Status species in Montana.

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INTRODUCTION

Several species of North American cave-dwelling bats have been adversely affected in recent decades by a variety of human-induced environmental changes to caves, including cave closures, impoundments, and vandalism or other direct human disturbances (see Humphrey 1978, Tuttle 1979, LaVal and LaVal 1980, Sheffield et al. 1992.). These, and landscape changes such as deforestation (including loss of large trees with basal hollows) and agricultural development, have forced many bat species to abandon traditional sites in search of new roosts and hibernacula. As a result of these wide-spread disturbances, some cave-dwelling species in the eastern and Midwestern United States have been listed as threatened or endangered under the U.S. Endangered Species Act. Abandoned mines offer a variety of subterranean microclimates similar to those in natural caves (Tuttle and Stevenson 1978, Tuttle and Taylor 1994) and can provide suitable habitat for roosting and hibernating bats. Abandoned mines now serve as principle roosts and hibernacula for many cave-dwelling species (Tuttle and Taylor 1994), and are important for populations occupying marginal habitats (Gates et al. 1984) in areas where there are continued threats to primary natural roosts. It is widely acknowledged that natural cave environments are the most stable and desirable long-term habitats for bats, but abandoned mines may provide a suitable alternative.

Mine reclamation (including closure to restrict human access) is of interest to wildlife managers because reclamation activities can have significant negative impacts on bat populations (see Sheffield et al. 1992, Richter et al. 1993). Therefore, it is important that closure is done in such a way as to minimize disturbance to bats in the mines affected. Because the majority of bat species in Montana use caves and mines, it is especially important to determine the extent and magnitude of mine use by bats in the state, and identify situations where access by humans to abandoned mines can be restricted while maintaining mine attractiveness to bats.

Increased concern over bat populations nationally, coupled with increased emphasis on the closure of abandoned mines on public lands, has prompted Bureau of Land Management (BLM) biologists in Montana to assess abandoned mines for bat activity prior to mine closure (e.g., Hendricks 1997, Hendricks et al. 1999). A number of abandoned mines in west-central Montana on BLM lands under jurisdiction of the Missoula Field Office are scheduled for closure in the near future. Some of these mines may provide habitat critical for hibernation, reproduction, and warm-season roosting by bats, including Townsend's Big-eared Bat (*Corynorhinus townsendii*), a designated Special Status species by the BLM in Montana. Objectives of the surveys reported here include 1) assessing the suitability of several abandoned mine workings as bat habitat, and 2) providing management suggestions that assist in reclamation activities at these workings.

STUDY AREA AND METHODS

Three groups of abandoned mine workings in the Philipsburg, Granite County, Montana area were identified by Missoula Field Office BLM personnel for assessment as bat habitat prior to reclamation activity. These included the Russian Gulch Mine (2 adits) above Rock Creek about 11 miles WSW of Philipsburg (T6NR15WS8NWSE; 5200 ft elevation), the Frost Creek workings (5 adits) just SE of Philipsburg (T7NR13WS30SE and S31NW), and the "Cliff Creek" workings (7 adits, 1 shaft), also just SE of Philipsburg in the next drainage north of Frost Creek and south of Camp Creek (T7NR13WS30SW); elevation of workings in the Frost Creek and "Cliff Creek" groups ranged between 5600 and 6000 ft. The last two groups of workings exist among a confusing clutter of other old mining activity on patented claims, therefore site designations follow those provided by BLM personnel (Dave McCleerey and Mindy Mason) as shown in Fig. 1 (Frost Creek workings) and Fig. 2 ("Cliff Creek" workings).

Mine workings were visually inspected for bat spoor (guano, insect parts, bats themselves). Configuration and size of portals were recorded and notes taken on entrance stability. Where deemed safe and suitable, mines were entered and inspected internally. If possible, mine air temperature and relative humidity were recorded at measured distances from portals using a Bacharach sling psychrometer. Air movement and direction were also noted, and extent of underground workings was measured using a meter tape.

Ultrasound electronic bat detectors (ANABAT II; Titley Electronics, Ballina, Australia) were used at workings that appeared to have greatest potential for use by bats, or where for safety reasons open workings were not inspected internally. These units are sensitive to broadband ultrasonic calls common in bat vocalizations (usually 20-180 kHz). Calls are captured and converted to an audible frequency, and recorded on magnetic tape for later analysis. Detector units (consisting of a detector, timer/tape driver delay switch, and a voice-activated tape recorder) were set up before dusk at mine portals (facing into the adit) and left overnight. Recorded calls were analyzed on an IBM compatible PC using ANABAT ZCAM software. Assignment of vocalizations to a particular species of bat is achieved by matching field recordings with reference sets of calls or descriptions from the published literature (e.g., Fenton et al. 1983, O'Farrell 1997). However, bat species can show significant variation in call structure (Betts 1998, Barclay 1999), and flying bats were not actively tracked and recorded (O'Farrell et al. 1999) to maximize quality and quantity of diagnostic sequences. Furthermore, units were situated where they would record bats exiting roosts or flying near potential roosts. Roost-exit calls and calls in high clutter tend to be fragmentary, lacking diagnostic features necessary for species identification (O'Farrell 1999). Therefore, all species-level identifications based on recorded vocalizations, where made during this survey, are considered tentative.

Mist nets (50 denier, 2.6 m length) were deployed at dusk across mine portals where deemed appropriate and left open for two hours. During this survey netting occurred only at the Russian Gulch Mine.

The databases at the Montana Natural Heritage Program were examined for bat records from Granite County. These include museum specimens and other observations, and indicate the potential array of bat species that could use abandoned mines in the survey area. A list of database records is provided in the Discussion section of this report.

RESULTS

Russian Gulch Mine: The Russian Gulch Mine workings (T6NR15WS8NWSE) consist of two open adit portals and one completely collapsed portal. The two open portals are connected by the underground workings. The upper, southern portal was entered on 9 July 1999. The passage slopes downward and to the N for 11 m, where it intersects a drift that runs level approximately E-W for 47 m. About halfway along this passage it intersects another passage that trends downward (N) for 13 m. This then intersects a second E-W trending drift. The second (northern) open portal is 28 m to the W from this point. To the east there is considerable breakdown beyond 10 m, and the full extent of this passage was not explored. Dry bulb temperatures at either end of the connecting (13 m) passage were 43°F with 94% relative humidity. Dry bulb temperature at the S portal was 77°F (relative humidity = 25%) at this time (16:30 MDT). Total measured passage was 109 m, with largest dimensions of about 2.2 X 1.5 m (height X width). Height and width of the largest open portal (the southern one) were 0.7m and 1.5 m, respectively. There was little evidence of human disturbance and the workings are essentially dry. Warm air gently flowed into the mine through the southern portal, cooler air flowed out of the mine through the northern portal.

A Bushy-tailed Woodrat (*Neotoma cinerea*) was observed in the upper 47 m drift, where Porcupine (*Erethizon dorsatum*) droppings were also present. No bats or bat spoor were seen during the hour-long inspection. The southern portal was netted for two hours (21:30-23:30). No bats were captured, and none made passes near the portal. However, bats made about 16 passes in the general area of the two portals during that time. Most passes were by some species of *Myotis* (based on visual observation) while a few passes were made by a second larger species (perhaps Big Brown Bat, *Eptesicus fuscus*). No bat calls were recorded overnight at either open portal on ANABAT units.

Frost Creek #1: This site (T7NR13WS31SENW) was not inspected, per BLM suggestion.

Frost Creek #2: This adit (T7NR13WS31NENW) has a partially open portal with a wooden headframe and shoring, extending level and curving to the left in about 8-10 m. It was not entered when visited on 10 July. No air movement was noted at the portal. A few intact cobwebs extended across the opening. No bat activity was recorded overnight on an ANABAT unit.

Frost Creek #3: This adit (T7NR13WS30SESW) in lower Frost Creek is collapsed about 6-8 m in from the portal, headframe and shoring, and has low potential for significant use by bats. It was not monitored overnight.

Frost Creek #4: This adit (T7NR13WS30SWSE) adjacent to the Frost Creek road consists of a partially open portal (0.8 m high X 1.9 m wide) that leads into a level drift extending 27 m to the drift face. Drift height and width are 2.0 m and 1.5 m, respectively. A few cobwebs hung across the portal at the time of inspection (13:05 MDT) on 10 July. Dry bulb temperature at the drift face was 45°F with 94% relative humidity. A few old bat droppings were present near the drift face, but there was no evidence of recent bat activity. No bats were recorded on an ANABAT unit left overnight at the portal.

Figure 1. Mine workings surveyed in July 1999 in the Frost Creek drainage near Philipsburg, Granite County, Montana.

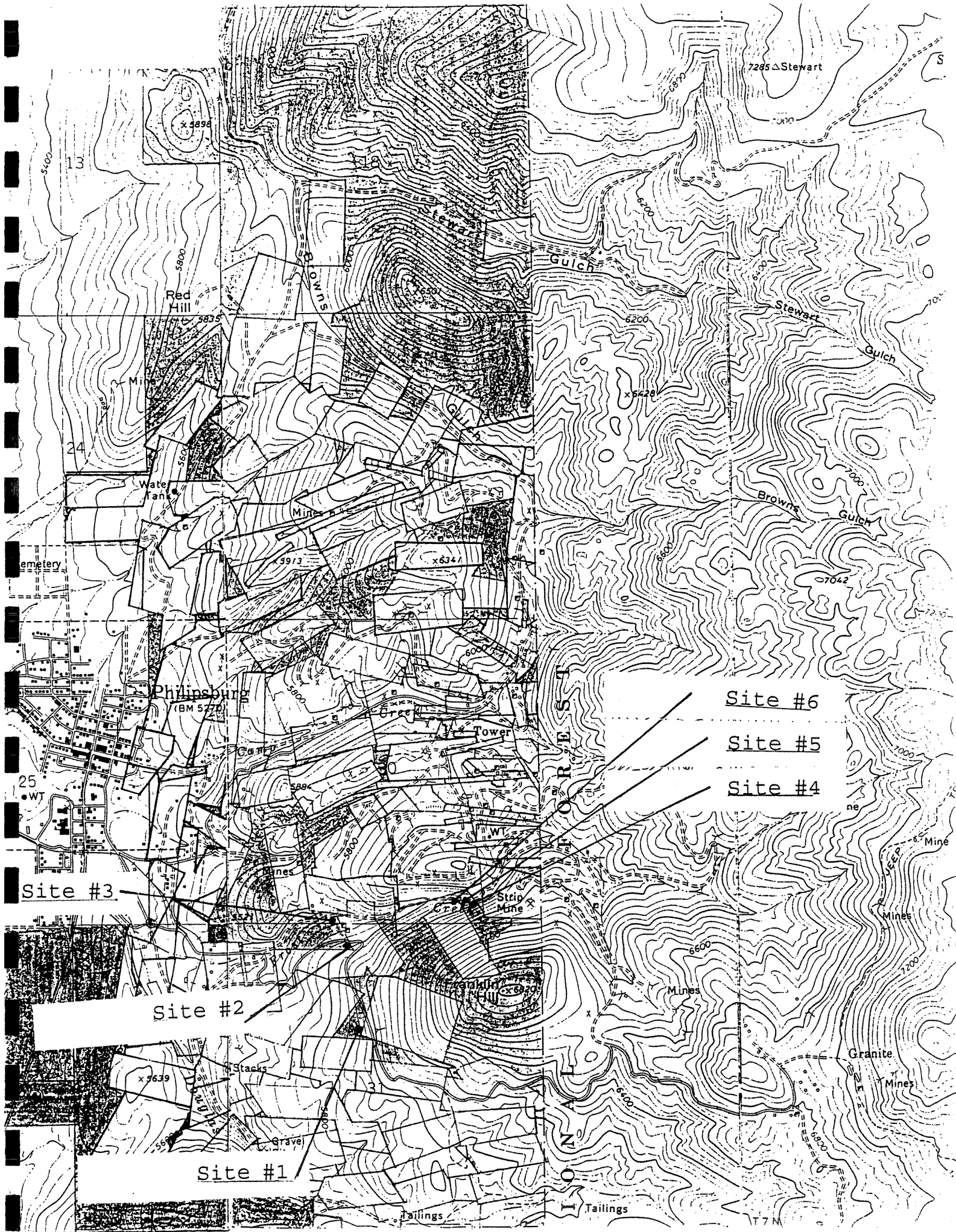


Figure 2. Mine workings surveyed in July 1999 in the “Cliff Creek” drainage near Philipsburg, Granite County, Montana.

Frost Creek #5: This adit (T7NR13WS30SWSE) is near adit #4 but farther off of the road. The portal consists of a partially collapsed entrance behind a partially collapsed wooden headframe. The largest opening was 1.2 m high by 0.5 m wide obstructed with cobwebs. This mine was not entered. No bat calls were recorded on an ANABAT unit left overnight at the portal on 10 July.

Frost Creek #6: This adit (T7NR13WS30SWSE) near adits #4 and #5 is completely collapsed and was not monitored because of no potential for use by bats.

Cliff Creek #1: This adit (T7NR13WS30SWSW) is mostly collapsed, extending only 4 m from the "portal". It was not monitored because of low potential for use by bats.

Cliff Creek #2: This adit (T7NR13WS30SWSW) has been secured with a culvert installed in the portal, and sealed with a metal-mesh grating. The extent of workings behind the grate is unknown. It was not monitored overnight because the grating precluded use of the working by bats.

Cliff Creek #3: This adit (T7NR13WS30NESW) is on the S-facing slope near the workings #4 and #5. The working is a gently sloping decline, collapsed ca. 8 m from the portal. There was no evidence of bat use and the site was not monitored overnight because of low potential for use by bats.

Cliff Creek #4: This adit (about 8 m E of adit #3) extends only 3 m beyond the portal. There was no evidence of use by bats and the site was not monitored overnight because of low potential for use by bats.

Cliff Creek #5: This site (up drainage from adit #4) is comprised of two shallow workings. #5a is collapsed < 2 m from the portal (which is situated behind a mature Douglas-fir). #5b is a decline extending 8 m from the portal to the drift. The portal is located behind a rocky mountain juniper. There was no evidence of use by bats in either working. Both workings had little potential for significant use by bats and were not monitored overnight.

Cliff Creek #6: This adit (down slope and between adits #5a and #5b) consists of an open portal 1.5 m tall by 1.0 m wide and secured with a cable net (mesh size = 14 X 14 cm). The cable netting can be bypassed by people, but there was no evidence of recent human activity within the working. The drift is level and extends 22 m to the drift face, curving to the left (W) in the last 10 m. The drift itself is 2.0 m tall by 1.1 m wide. Dry bulb temperature at the drift face was 54°F with 80% relative humidity at 15:50 on 10 July. Dry bulb temperature outside at the portal was 57°F. No bat guano was found. The site was not monitored overnight because the cable netting would deter use by bats.

Cliff Creek #7: This shaft (T7NR13WS30SWSW) on the ridge crest above adit #3 is a simple and shallow working, extending 8-9 m deep below a portal entrance 2 X 1 m in dimensions. Although the working was not entered, there was no evidence of side workings. The site has low potential for significant use by bats and was not monitored overnight.

DISCUSSION

Most of the mine workings examined during this survey in the Philipsburg area had low potential for significant use by bats. At best, the majority of accessible workings might be used as night roosts by one or a few individuals, sites where bats rest and digest food following emergence and foraging. Nevertheless, few workings offered any evidence of use, recent or otherwise, by bats.

The Russian Gulch Mine, because of the extent of workings and movement of air through the mine, has the greatest potential for use by bats but there is no evidence that it is currently used by them. Lack of use may be related to the size of the portal openings, but bats are known to use sites with openings this size or smaller (personal observation). In its present state this mine is most suitable as a hibernaculum, because it is relatively cold and humid, factors not favored by female bats for raising young (see Humphrey and Kunz 1976, Betts 1997).

Other workings most likely to be used by bats include the Frost Creek adit #4 (old droppings present, but no activity detected during overnight monitoring), and the Cliff Creek adit #6 (obstructed with cable netting and no droppings present, but might be used if the netting was removed). Both workings are simple and relatively shallow (22-27 m in extent), and would be used by only a few bats at a time. The Frost Creek adit #4 is most likely to be used as a night roost because of its N-facing aspect and cooler, more humid mine climate. The Cliff Creek adit #6, on the other hand, has a S-facing aspect, and is warmer and less humid than the Frost Creek working. This site has potential for use as a maternity roost by a few individuals or as a night roost (see Hendricks 1999). Both sites have the potential for use as hibernacula, but more detailed climate data are needed to support this contention.

Few bats were observed during the mine survey, and those seen (in flight) were not identified to species, although at least two species were observed (based on size differences and vocalizations). Several species of bats could occupy the survey area, including several species that use caves and mines. Western Long-eared Myotis (*Myotis evotis*), Little Brown Myotis (*M. lucifugus*), and Long-legged Myotis (*M. volans*), all mine-dwelling species, have been collected from Granite County (Table 1). Other species reported from Granite County, based mostly on

Table 1. Bat specimens collected from Granite County, Montana.

SPECIES	COLLECTION NUMBER ^a	LOCATION	DATE
<i>Myotis evotis</i>	UMZ 193	Upper Rock Cr., 5 mi. above ranger station	28 July 1945
<i>Myotis evotis</i>	UMZ 9884	Garnet Ghost Town	18 October 1964
<i>Myotis lucifugus</i>	UMZ 3856	Wagner Cave, 5 mi. E of Maxville	5 December 1952
<i>Myotis lucifugus</i>	CMNH 21829	Echo Lake, 25 mi. W of Anaconda	12 August 1943
<i>Myotis volans</i>	CMNH 21849	Echo Lake, 25 mi. W of Anaconda	12 August 1943
<i>Myotis volans</i>	UMZ 3854	Wagner Cave, 5 mi. E of Maxville	5 December 1952
<i>Myotis volans</i>	UMZ 13133	43 road mi. ESE of Hamilton on Skalkaho Rd [W Fork Rock Cr.]	10 August 1961

^a UMZ (University of Montana Zoological Museum), CMNH (Carnegie Museum of Natural History).

vocal analyses (Table 2; see also Hendricks 1997), include Western Small-footed Myotis (*M. ciliolabrum*), Western Long-eared Myotis, Big Brown Bat (*Eptesicus fuscus*), Townsend's Big-eared Bat (*Corynorhinus townsendii*), Silver-haired Bat (*Lasionycteris noctivagans*), and Hoary Bat (*Lasiurus cinereus*). The latter two species rarely associate with mines or caves (van Zyll de Jong 1985, Nagorsen and Brigham 1993, Harvey et al. 1999). Other species not reported

Table 2. Non-specimen records of bats from Granite County, Montana.

SPECIES	LOCATION	DATE
<i>Myotis ciliolabrum</i>	Douglas Cr. Mines T9NR12WS31	1992
<i>Myotis evotis</i>	Douglas Cr. Mines T9NR12WS31	1992
<i>Myotis evotis</i>	Silver King Mine T6NR15WS5SE	27 July 1997
<i>Eptesicus fuscus</i>	Douglas Cr. Mines T9NR12WS31	1992
<i>Eptesicus fuscus</i>	Boulder Creek T7NR12WS9	18 August 1992
<i>Eptesicus fuscus</i>	Londonderry Mine T8NR13WS9NW	11 June 1996
<i>Eptesicus fuscus</i>	Mountain View Mine T12NR14WS2SW	26 July 1997
<i>Eptesicus fuscus</i>	Silver King Mine area T6NR15WS5SE	27 July 1997
<i>Corynorhinus townsendii</i>	Londonderry Mine T8NR13WS9NW	11 June 1996
<i>Corynorhinus townsendii</i>	Mountain View Mine T12NR14WS2SW	26 July 1997
<i>Corynorhinus townsendii</i>	Silver King Mine area T6NR15WS5SE	27 July 1997
<i>Lasionycteris noctivagans</i>	Copper Creek Campground T4NR16WS25	6 August 1991
<i>Lasionycteris noctivagans</i>	W. Fork Rock Creek/Sand Basin T5NR17WS11	7 August 1991
<i>Lasionycteris noctivagans</i>	Rock Creek near Squaw Rock T7NR16WS16	8 August 1991
<i>Lasionycteris noctivagans</i>	Silver King Mine T6NR15WS5SE	27 July 1997
<i>Lasiurus cinereus</i>	Copper Creek Campground T4NR16WS25	6 August 1991
<i>Lasiurus cinereus</i>	W. Fork Rock Creek/Sand Basin T5NR17WS11	7 August 1991

in Granite County, but that may occur there include California Myotis (*M. californicus*), Yuma Myotis (*M. yumanensis*), and Fringed Myotis (*M. thysanodes*). Specimens of each species have been collected to the west in adjacent Ravalli County (Hoffmann et al. 1969).

Of the documented species in Granite County, Western Small-footed Myotis, Western Long-eared Myotis, Long-legged Myotis, and Townsend's Big-eared Bat are U.S. Fish and Wildlife Service "species of concern" (Harvey et al. 1999), former category 2 candidates for listing under the Endangered Species Act. Each species has been reported using mines and caves elsewhere in Montana (Swenson 1970, Swenson and Shanks 1979, Hendricks et al. 1996, Hendricks et al. 1999, Hendricks et al. 2000). Of the potentially occurring species documented in adjacent Ravalli County, the Fringed Myotis and Yuma Myotis are also USFWS "species of concern".

MANAGEMENT CONSIDERATIONS

Three abandoned mine workings inspected during this 1999 survey offer real or potential habitat for bat use. These include the Russian Gulch Mine, the Frost Creek adit #4, and the "Cliff Creek" adit #6. Each would be suitable for gating with a bat-friendly design. However, if monetary resources are limited for reclamation activity, the gating option should be reconsidered. None of the workings had evidence of recent bat activity, and only one site (Russian Gulch Mine) had any complexity to the underground workings. This latter site is one mile S of the Silver King Mine, which offers even better bat habitat and was in use at the time it was surveyed in July 1997. Highest priority sites should include known or potential maternity and/or hibernation roosts (Tuttle and Taylor 1994). However, even smaller workings could provide important roosting sites for bats during migration. Although lack of recent bat spoor in the three best workings indicates that they are currently used by few, if any bats, each could be used in the future.

For the "Cliff Creek" adit # 6, lack of current use is likely a result of the cable netting, which should be replaced with a bat-friendly gate or grate (e.g., Tuttle and Taylor 1994, Dalton and Dalton 1995). A similar gate/grating design could be used at the Frost Creek adit #4. Both sites are adjacent to areas with relatively heavy human activity. Any design used in these areas will need to withstand the onslaught of determined gate-busters. Portals at both sites are in fairly stable bedrock, which should allow secure anchorage of gates. A gated culvert system, like that used by the Mine Waste Cleanup Bureau of the Montana Department of Environmental Quality (Hendricks 1999), would be most appropriate at the Russian Gulch Mine, where the slope surrounding the portals is unstable and more likely to slump. If bat-friendly reclamation activity is conducted at this mine, both portals should be left open to maintain airflow through the mine.

The remaining accessible mine workings can be closed with little likelihood of negatively impacting the local bat fauna.

LITERATURE CITED

- Barclay, R. M. R. 1999. Bats are not birds—a cautionary note on using echolocation calls to identify bats: a comment. *Journal of Mammalogy* 80:290-296.
- Betts, B. J. 1997. Microclimate in Hell's Canyon mines used by maternity colonies of *Myotis yumanensis*. *Journal of Mammalogy* 78:1240-1250.
- Betts, B. J. 1998. Effects of interindividual variation in echolocation calls on identification of Big Brown and Silver-haired bats. *Journal of Wildlife Management* 62:1003-1010.
- Dalton, D. C., and V. M. Dalton. 1995. Mine closure methods including a recommended gate design. Pp. 130-135 in Riddle, B. R. (ed.). Inactive mines as bat habitat: guidelines for research, survey, monitoring and mine management in Nevada. Biological Resources Research Center, University of Nevada, Reno.
- Fenton, M. B., H. G. Merriam, and G. L. Holroyd. 1983. Bats of Kootenay, Glacier, and Mount Revelstoke national parks in Canada: identification by echolocation calls, distribution, and biology. *Canadian Journal of Zoology* 61:2503-2508.
- Gates, J. E., G. A. Feldhamer, L. A. Griffith, and R. L. Raesley. 1984. Status of cave-dwelling bats in Maryland: importance of marginal habitats. *Wildlife Society Bulletin* 12:162-169.
- Harvey, M. J., J. S. Altenbach, and T. L. Best. 1999. Bats of the United States. Arkansas Game & Fish Commission and the U.S. Fish and Wildlife Service. 64 pp.
- Hendricks, P. 1997. Mine assessments for bat activity, Garnet Resource Area, BLM: 1997. Montana Natural Heritage Program. Helena, MT. 17 pp.
- Hendricks, P. 1999. Effects of gate installation in continued use by bats of four abandoned mine workings in western Montana. Unpublished report to Montana Department of Environmental Quality. Montana Natural Heritage Program. Helena, MT. 13 pp.
- Hendricks, P., D. L. Genter, and S. Martinez. 2000. Bats of Azure Cave and the Little Rocky Mountains, Montana. *Canadian Field-Naturalist* 114: in press.
- Hendricks, P., K. A. Jurist, D. L. Genter, and J. D. Reichel. 1996. Bats of the Kootenai National Forest, Montana. Montana Natural Heritage Program. Helena, MT. 99 pp.
- Hendricks, P., D. Kampwerth, and M. Brown. 1999. Assessment of abandoned mines for bat use on Bureau of Land Management lands in southwestern Montana: 1997-1998. Montana Natural Heritage Program. Helena, MT. 29 pp.
- Hoffmann, R. S., D. L. Pattie, and J. F. Bell. 1969. The distribution of some mammals in Montana. II. Bats. *Journal of Mammalogy* 50:737-741.
- Humphrey, S. R. 1978. Status, winter habitat, and management of the endangered Indiana Bat, *Myotis sodalis*. *Florida Science* 41:65-76.
- Humphrey, S. R., and T. H. Kunz. 1976. Ecology of a Pleistocene relict, the Western Big-eared Bat (*Plecotus townsendii*), in the southern Great Plains. *Journal of Mammalogy* 57:470-494.
- LaVal, R. K., and M. L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Department of Conservation, Terrestrial Series #8. 53 pp.
- Nagorsen, D. W., and R. M. Brigham. 1993. The bats of British Columbia. University of British Columbia Press, Vancouver, British Columbia. 164 pp.
- O'Farrell, M. J. 1997. Use of echolocation calls for the identification of free-flying bats. *Transactions of the Western Section of The Wildlife Society* 33:1-8.

- O'Farrell, M. J. 1999. Blind test for ability to discriminate vocal signatures of the Little Brown Bat *Myotis lucifugus* and the Indiana Bat *Myotis sodalis*. *Bat Research News* 40:44-48.
- O'Farrell, M. J., B. W. Miller, and W. L. Gannon. 1999. Qualitative identification of free-flying bats using the Anabat detector. *Journal of Mammalogy* 80:11-23.
- Richter, A. R., S. R. Humphrey, J. B. Cope, and V. Brack, Jr. 1993. Modified cave entrances: thermal effect on body mass and resulting decline of endangered Indiana Bats (*Myotis sodalis*). *Conservation Biology* 7:407-415.
- Sheffield, S. R., J. H. Shaw, G. A. Heidt, and L. R. McClenaghan. 1992. Guidelines for the protection of bat roosts. *Journal of Mammalogy* 73:707-710.
- Swenson, J. E. 1970. Notes on distribution of *Myotis leibii* in eastern Montana. *Blue Jay* 28:173-174.
- Swenson, J. E., and G. F. Shanks, Jr. 1979. Noteworthy records of bats from northeastern Montana. *Journal of Mammalogy* 60:650-652.
- Tuttle, M. D. 1979. Status, causes of decline, and management of endangered Gray Bats. *Journal of Wildlife Management* 43:1-17.
- Tuttle, M. D., and D. E. Stevenson. 1978. Variation in the cave environment and its biological implications. Pp. 108-121 in 1977 National Cave Management Symposium Proceedings (R. Zuber, J. Chester, S. Gilbert, and D. Roberts, eds.). Adobe Press, Albuquerque, NM. 140 pp.
- Tuttle, M. D., and D. A. R. Taylor. 1994. Bats and mines. *Bat Conservation International Resource Publication Number 3*. 41 pp.
- van Zyll de Jong, C. G. 1985. Handbook of Canadian mammals. 2. Bats. National Museum of Natural Sciences. Ottawa, Ontario. 212 pp.